SURVIVAL OF INDIANMEAL MOTH AND NAVEL ORANGEWORM AT LOW TEMPERATURES

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The navel orangeworm, *Amyelois transitella*, and Indianmeal moth, *Plodia interpunctella*, are important postharvest insect pests of California dried fruits and nuts. As cold-blooded animals, these insects are unable to feed, develop or reproduce below developmental thresholds of about 14°C (57°F). Extended exposure to temperatures below developmental thresholds eventually cause death. Dried fruit and nut processors often store their product at temperatures of 5°C (41°F) or below to maintain quality and lengthen self-life. Cold storage may also be used to protect product from insect infestation, and as a possible disinfestation treatment. We have determined the life stages that are most tolerant to 0, 5, and 10°C (32, 41 and 50°F) and have estimated the exposures necessary for disinfestation at 0 and 5°C.

Methods

Navel orangeworm and Indianmeal moth used for this study were from laboratory cultures maintained by the USDA-ARS, Parlier, CA. Larvae and pupae of both species were placed in stainless steel screen vials capped with cork stoppers. The vials were placed in plastic desiccator jars where humidity levels of about 20, 50 and 80% were maintained with glycerin solutions. The jars were kept at 0, 5 and 10°C (32, 41 and 50°F) for different exposure times. After exposure, test pupae were removed from the vials and held for moth emergence. Vials with test larvae were opened and placed in pint jars with a small amount of rearing medium and held for pupation. Survival was calculated from the number of test insects reaching the next stage, and corrected for control mortality. The results were compared with earlier work done with Indianmeal moth and navel orangeworm eggs.

Results

Humidity level appeared to have no consistent effect on insect survival at low temperatures. Consequently, data for humidity levels were combined. At 10°C, larvae of both Indianmeal moth and navel orangeworm were considerably more tolerant than pupae (Table 1). Over 50% of Indianmeal moth and navel orangeworm larvae survived 40 days of expsoure to 10°C, but no pupae survived exposure for 33 days. After 40 days at 10°C, survival of Indianmeal moth larvae was 81.6%, compared to only 52.3% for navel orangeworm larvae, indicating that Indianmeal moth is more tolerant at this temperature.

We found that the relative tolerance of life stages changed at lower treatment temperatures. Navel orangeworm pupae were more tolerant than larvae at both 5 and 0°C. Cold tolerance of Indianmeal moth larvae was only slightly more than pupae at 5°C, and slightly less than pupae at 0°C. Relative tolerance of Indianmeal moth and navel orangeworm pupae was roughly similar at all temperatures, while Indianmeal moth larvae were more tolerant than navel orangeworm larvae at all temperatures. Earlier studies (Johnson et al 1997, Johnson and Valero 1999) indicate that pupae of both species are more cold tolerant than eggs (Table 2.) at all temperatures. Indianmeal moth larvae were more tolerant than eggs at 10 and 5°C, but were similar in tolerance at 0°C. Navel orangeworm larvae were more tolerant than eggs at 10°C, but similar in tolerance at both 5 and 0°C.

Conclusions

Our results indicate that long exposures would be necessary to disinfest product of either Indianmeal moth or navel orangeworm larvae at 10°C (50°F). Shorter exposures were obtained at lower temperatures, with near complete mortality reached after 25 days at 5°C (41°F) and after 12 days at 0°C (32°F). Because these temperatures are more likely to be used under commercial conditions, disinfestation of stored product may be possible with little change to normal storage practices. However, the method will not be applicable to product that requires rapid treatment.

Overview of Low Temperature Disinfestation

Advantages

- For product that is routinely stored at low temperatures to maintain quality, cost of using the method would be minimal.
- Quality of most products is unharmed or enhanced, and storage life improved.
- No chemical residues are present.
- Application of method is simple and safe, and equipment is readily available.
- Method can be used in combination with other treatments.

Disadvantages

- If not already being used to maintain quality, method would require large capital outlay for refrigeration equipment, and increased power costs.
- Treatment times, even at 0°C, are lengthy (at least 2 weeks), and would not be suitable for products requiring rapid treatments.
- Leaks of ammonium refrigerants can damage nuts (other refrigerants recommended).

References Cited

Johnson, J. A., K. A. Valero, and M. M Hannel. 1997. Effect of low temperature storage on survival and reproduction of Indianmeal moth (Lepidoptera: Pyralidae). Crop Protection. 16: 519-523.

Johnson, J. A., and K. A. Valero. 1999. Response of navel orangeworm and Indianmeal moth eggs to low temperature storage. Annual International Research Conference on Methyl Bromide Alternatives and Emissions Reductions. p. 65.1-2.

Table 1. Survival of Indianmeal moth and navel orangeworm larvae and pupae exposed to low temperatures.

Exposure (days)	Indianmeal moth		Navel orangeworm	
	Larvae	Pupae	Larvae	Pupae
		10°C (50°F)		
12	81.1	19.8	94.2	34.2
19	88.2	6.9	83.7	18.5
26	89.8	7.9	71.5	2.1
33	85.7	0.0	61.6	0.0
40	81.6	0.0	52.3	0.0
		5°C (41°F)		
5	78.9	56.5	27.5	89.0
10	23.4	27.2	1.4	55.8
15	12.8	13.2	0.5	29.5
20	10.6	1.5	0.0	0.5
25	1.1	0.0	0.0	0.0
		0°C (32°F)		
4	27.2	66.9	2.1	41.2
6	5.9	47.7	0.0	9.9
8	1.5	31.5	0.0	4.6
10	1.5	2.8	0.0	6.9
12	0.0	5.7	0.0	0.0

Values are % survival corrected for untreated control mortality

Table 2. LT_{95} (days) for Indianmeal moth and navel orangeworm eggs.

Temperature	Indianmeal moth	Navel orangeworm
10°C (50°F)	11.6	9.1
5°C (41°F)	9.8	7.1
0°C (32°F)	7.7	2.8

From Johnson and Valero, 1999